We Claim

1. A gas turbine engine exhaust nozzle arrangement for the flow of exhaust gases therethrough between an upstream end and a downstream end thereof comprising a nozzle, a downstream portion and a plurality of tabs, each tab extends in a generally axial direction from the downstream portion of the nozzle wherein the nozzle further comprises an actuation mechanism capable of moving the tabs between a first deployed position, in the first position the tabs interact with a gas stream to reduce exhaust noise thereof, and a second non-deployed position, in the second position the tabs are substantially aerodynamically unobtrusive.

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2. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the plurality of tabs is circumferentially disposed about the nozzle.

3. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the actuation mechanism comprises a shape memory material element.

4. A gas turbine engine exhaust nozzle arrangement as claimed in claim 3, the nozzle further comprises a radially inner position and a radially outer part, wherein the tabs are rotatably attached to the nozzle at the radially inner position, the actuation mechanism comprises the shape memory element mounted at a first end to a radially outer part of the nozzle and mounted at a distal end to a radially outer part of the tab, such that in use, the element in a first shape maintains the tab in the second non-deployed position and in a second shape maintains the tab in the first deployed position.

5. A gas turbine engine exhaust nozzle arrangement as claimed in claim 3 wherein the periphery of the nozzle defines a pocket therein and at least a part of the element is generally disposed within the pocket.

6. A gas turbine engine exhaust nozzle arrangement as claimed in claim 3 wherein the tab defines a recess therein

and at least a part of the element is generally disposed within the recess.

7. A gas turbine engine exhaust nozzle arrangement as claimed in claim 3 wherein the element is in the form of a spring.

8. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the nozzle arrangement comprises a resilient member having a first end and a distal end, the resilient member is attached at the first end to the tab and at the distal end to the nozzle and is arranged to provide a returning force to the tab.

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9. A gas turbine engine exhaust nozzle arrangement as claimed in claim 5 wherein the nozzle defines an orifice and a passage, the orifice is exposed to a gas stream and the passage extends from the orifice to the pocket and thereby provides a conduit for transmitting the thermal flux of the gas stream to the actuation mechanism.

10. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the tab comprises shape memory material.

11. A gas turbine engine exhaust nozzle arrangement as claimed in claim 10 wherein the tab further comprises a flexural element, the flexural element, in use, is arranged to provide a returning force to the tab.

12. A gas turbine engine exhaust nozzle arrangement as claimed in claim 10 wherein the tab defines an orifice, the orifice exposed to a gas stream, and a passage, the passage extending from the orifice, to the shape memory material and thereby provides a conduit for rapidly transmitting changes in the thermal flux of the gas stream to and throughout the memory shape material element.

13. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the actuation mechanism is actuated in a response to an applied field.

14. A gas turbine engine exhaust nozzle arrangement as claimed in claim 13 wherein the field is a temperature flux.

15. A gas turbine engine exhaust nozzle arrangement as claimed in claim 13 wherein the field is an electric current.

16. A gas turbine engine exhaust nozzle arrangement as claimed in claim 13 wherein the temperature flux is provided by the gas stream and the gas stream is any one chosen from the group comprising an ambient gas flow, a bypass flow, a core flow.

a(17. A gas turbine engine exhaust nozzle arrangement as claimed in claim 2 wherein the shape memory material element comprises any one of a group comprising Titanium, Manganese, Iron, Aluminium, Silicon, Nickel, Copper, Zinc, Silver, Cadmium, Indium, Tin, Lead, Thallium, Platinum.

18. A gas turbine engine exhaust nozzle arrangement as claimed in claim 2 wherein the shape memory material element comprises an electrostrictive material.

19. A gas turbine engine exhaust nozzle arrangement as claimed in claim 18 wherein the actuation mechanism further comprises an electrical circuit, the electrical circuit comprising control apparatus, an electric generating means and electrical contact means, the electrical contact means arranged to deliver, in use, an electrical signal, generated by the electrical generating means, through the electrostrictive material, the control apparatus operable to control the electrical signal.

20. A gas turbine engine exhaust nozzle arrangement as claimed in claim 19 wherein when the control apparatus is operated to deliver the electrical signal to the electrostrictive material, thereby actuating the electrostrictive material, the tab is moved from a second non-deployed position and a first deployed position and when the control means is operated so as not to deliver the electrical signal the electrostrictive material moves the

tab between the first deployed position and the second non-deployed position.

21. A gas turbine engine exhaust nozzle arrangement as claimed in claim 19 wherein when the control apparatus is operated to deliver the electrical signal to the electrostrictive material, thereby actuating the electrostrictive material, the tab is moved between a first deployed position and a second non-deployed position and when the control means is operated so as not to deliver the electrical signal the electrostrictive material the tab is moved from the second non-deployed position and the first deployed position.

22. A gas turbine engine exhaust nozzle arrangement as claimed in claim 19 wherein the control apparatus, operable to control the electrical signal, is operated in response to the altitude of an associated aircraft.

23. A gas turbine engine exhaust nozzle arrangement as claimed in claim 18 wherein the electrostrictive material element comprises any one of a group comprising Lead Zirconate Titanate, Lead Magnesium Niobate and Strontium Titanate.

24. A gas turbine engine exhaust nozzle arrangement as claimed in claim 18 wherein the electrostrictive material element comprises any one of a polymer group including polyvinylidene fluoride.

25. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the downstream portion of the nozzle comprises a downstream periphery, the plurality of circumferentially disposed tabs extend in a generally downstream direction from the downstream periphery.

26. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the downstream portion of the nozzle defines a plurality of circumferentially disposed recesses, each recess receiving a tab.

27. A gas turbine engine exhaust nozzle arrangement as claimed in claim 26 wherein a tab, in a second non-deployed position, substantially occupies a recess.

28. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the tabs comprise a thermal barrier coating disposed to a surface thereof.

29. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the nozzle comprises a thermal barrier coating disposed to a surface thereof.

30. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the tabs circumferentially taper in the downstream direction.

31. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the tabs are radially inwardly angled at an angle of up to 20° relative to the nozzle wall.

32. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the tabs are radially outwardly angled at an angle of up to 20° relative to the nozzle wall.

33. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the tabs are circumferentially alternately radially inwardly angled at an angle of up to 20° relative to the nozzle wall and radially outwardly angled at an angle of up to 20° relative to the nozzle wall.

34. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the tabs are of a substantially trapezoidal shape.

35. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the general shape of the tabs is any one of the group comprising rectangular, square and triangular shape.

36. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the tabs are circumferentially disposed about the periphery of the nozzle wall to define

substantially trapezoidal shaped notches between adjacent tabs.

37. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the tabs are circumferentially disposed about the periphery of the nozzle wall to define substantially V-shaped notches between adjacent tabs.

38. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the edges of the tabs are curved.

39. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the nozzle tabs are radially inwardly angled at an angle of up to 10° relative to the nozzle wall.

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40. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the tabs extend in circumferentially alternating radially inward and outward directions for mixing the exhaust gas streams.

41. A gas turbine engine exhaust nozzle arrangement as claimed in claim 2 wherein the actuation mechanism comprises the shape memory element spanning between each circumferentially adjacent deployable tab, the shape memory element having a first length and a second length, so that in use, when the shape memory element is in its first shape the deployable tabs are in the first deployed position and when the shape memory element is in its second shape the deployable tabs are in the second non-deployed position.

42. A gas turbine engine exhaust nozzle arrangement as claimed in claim 41 wherein the first length of the shape memory element is longer than the second length, so that in use and in the first deployed position the deployable tabs are angled radially outwardly.

43. A gas turbine engine exhaust nozzle arrangement as claimed in claim 41 wherein the first length of the shape memory element is shorter than the second length, so that in use and in the first deployed position the deployable tabs are angled radially inwardly.

44. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein, in use as a noise reduction means, alternate tabs are rigidly fixed at a radially inward angle and deployable tabs are operable to move between a first deployed position at a radially outward angle, where the deployable tabs interact with a gas stream to reduce exhaust noise thereof, and a second non-deployed position, where the deployable tabs are substantially circumferentially aligned with the alternate tabs.

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45. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein, in use as a noise reduction means, alternate tabs are rigidly fixed at a second non-deployed position and deployable tabs are operable to move between a first deployed position at a radially inward angle, where the deployable tabs interact with a gas stream to reduce exhaust noise thereof, and a second non-deployed position, where the deployable tabs are substantially circumferentially aligned with the alternate tabs.

46. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the downstream periphery comprises straight edges, each straight edge having a tab disposed thereto.

47. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the actuation mechanism further comprises an end stop, the end stop is configured to provide a positive locator for the tab in either its deployed or non-deployed positions.

48. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the exhaust nozzle is a core engine nozzle.

49. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the exhaust nozzle is a bypass exhaust nozzle.

50. A ducted fan gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the arrangement

comprises a core exhaust nozzle and a bypass exhaust nozzle.

51. A ducted fan gas turbine engine exhaust nozzle arrangement comprising an outer bypass exhaust nozzle as claimed in claim 1, and an inner core exhaust nozzle of a lobed mixer type.

52. A ducted fan gas turbine engine exhaust nozzle arrangement as claimed in claim 51 wherein the downstream end of the bypass nozzle is further downstream than the downstream periphery of the core exhaust nozzle.

a1 53. A ducted fan gas turbine engine exhaust nozzle arrangement as claimed in claim 50 wherein the downstream end of the bypass nozzle is upstream of the downstream periphery of the core exhaust nozzle.

54. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the arrangement is for exhaust noise attenuation.

55. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the tabs extend generally in a downstream direction.

56. A gas turbine engine exhaust nozzle arrangement as claimed in claim 1 wherein the tabs extend generally in an upstream direction.

57. A method of operating an aircraft having a gas turbine engine comprising an exhaust nozzle arrangement as claimed in any preceding claim wherein the method comprises the steps of: deploying noise reduction means prior to take-off; not deploying noise reduction means above a predetermined aircraft altitude and; deploying the noise reduction means below the predetermined aircraft altitude.